Science

Abridged

Beyond the Point

- of -

Usefulness

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Science: Abridged Beyond the Point of Usefulness

Das is nicht einmal falsch.

- Wolfgang Pauli

PREFACE

This preface is a preface, which means that no one will read it. Like a black hole, there is information trapped here that will never be seen by human eyes. If you believe you are reading a preface right now, you are probably caught in a deeply warped spacetime, such as an event horizon or the customs line at an American airport. You may perceive yourself as alive, but to outside observers you are inert and motionless.

Since you are apparently here for eternity, without any option to turn away, I thought I'd tell you

about this book.

This book contains all of science. All of it. To be clear, I am using the word “science” in the narrow sense of fields which employ one of the known scientific methods. To wit:

1) Observation, experiment, analysis, conclusion

2) Observation, experiment, analysis, boring result, different analysis, different analysis, different analysis, interesting result, publication

3) Observation of other people’s work, repackaging, publication, tenure

4) Observation, experiment, catastrophic failure, less catastrophic failure, questionable success, publication, discovery that you’ve been scooped, alcoholism

5) Observation, experiment, analysis, world-shak-

ing discovery, rejection, desolation, death of elderly scientists, renewed interest, posthumous recognition

I have neglected to include some fields, such as Anthropology and its important subdiscipline, Sociology, as well as Economics and its important applied field, Evil. This is not because I consider these fields to be lesser, but because after reading the literature in quantitative finance, I realized I could do a separate Social Science book and make even more money. If any sociologists find themselves miffed while reading this, remember that your perception of your own anger is socially constructed, so suck it up.

I have also neglected to include the mathematical fields. This may seem odd, as these fields often claim priority over the whole of scientific knowl-

edge. But, it is now known that mathematics is in fact a narrow sub-domain of ichthyology, because if you take 1 fish and put it next to another fish, you have 2 fish. Add another, that's 3 fish. The rest can be derived from there, and I leave it as an exercise for the reader.

As a final caveat, I wish to note that if you happen to be a scientist yourself, you may feel your area of study was miscategorized. For example, I asked Linguistics to sit with the weirdos at the Cognitive Science table, while Paleontology was compelled to live with the smelly kids in Earth Science. I had hoped for a more pure and Platonic structure, but it turns out that the family tree of science contains more than a few kissing cousins. If your field appears to be in the wrong section, it is likely because you and your forebears were a bit promiscuous with your associations.

Shame on you. The more interdisciplinary science becomes, the harder it is for all of us to look down on chemists.

Zach Weinersmith

Weinersmith Manor

May, 2017

Introduction for the Teacher

Don’t teach from this.

Introduction for the Student

Don’t learn from this.

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1 PHYSICS

1.1 History

Aristotle said a bunch of stuff that was wrong. Galileo and Newton fixed things up. Then Einstein broke everything again. Now, we've basically got it all worked out, except for small stuff, big stuff, hot stuff, cold stuff, fast stuff, heavy stuff, dark stuff, turbulence, and the concept of time.

1.2 Major Insights

- If you punch the universe, it punches right back.
- If you know exactly where something is, you can be sure it's going between zero and 299,792,458 meters per second.
- You can get different stuff, but you can't get more stuff, and you can't get rid of stuff.
- Every time we check, God appears to be playing dice.

- It turns out gravity is less like a strong man tugging on a rope than a chubby man sitting on a trampoline.
- There are exactly three numbers: 0, 1, and ∞. The use of anything else is a form of dandyism.
- If you get a Physics professorship, later in life you can go around saying crazy stuff and people will believe you.

1.3 Subdisciplines

Thermodynamics: The study of how everything is getting worse all the time, and how if you speed that up a little you can run an engine.

Cosmology: The study of how a bunch of weird stuff happened in the first femtosecond of reality and then after that it got pretty dull.

Relativity: The study of how, if you have a clock and I have a clock, it doesn't mean a damn thing.

Condensed Matter Physics: The study of, like, chunks of stuff.

Astrophysics: The quantitative determination of the breadth of human insignificance.

Particle Physics: The attempt to determine the beautiful truth underlying reality by smashing little bits of it as hard as possible.

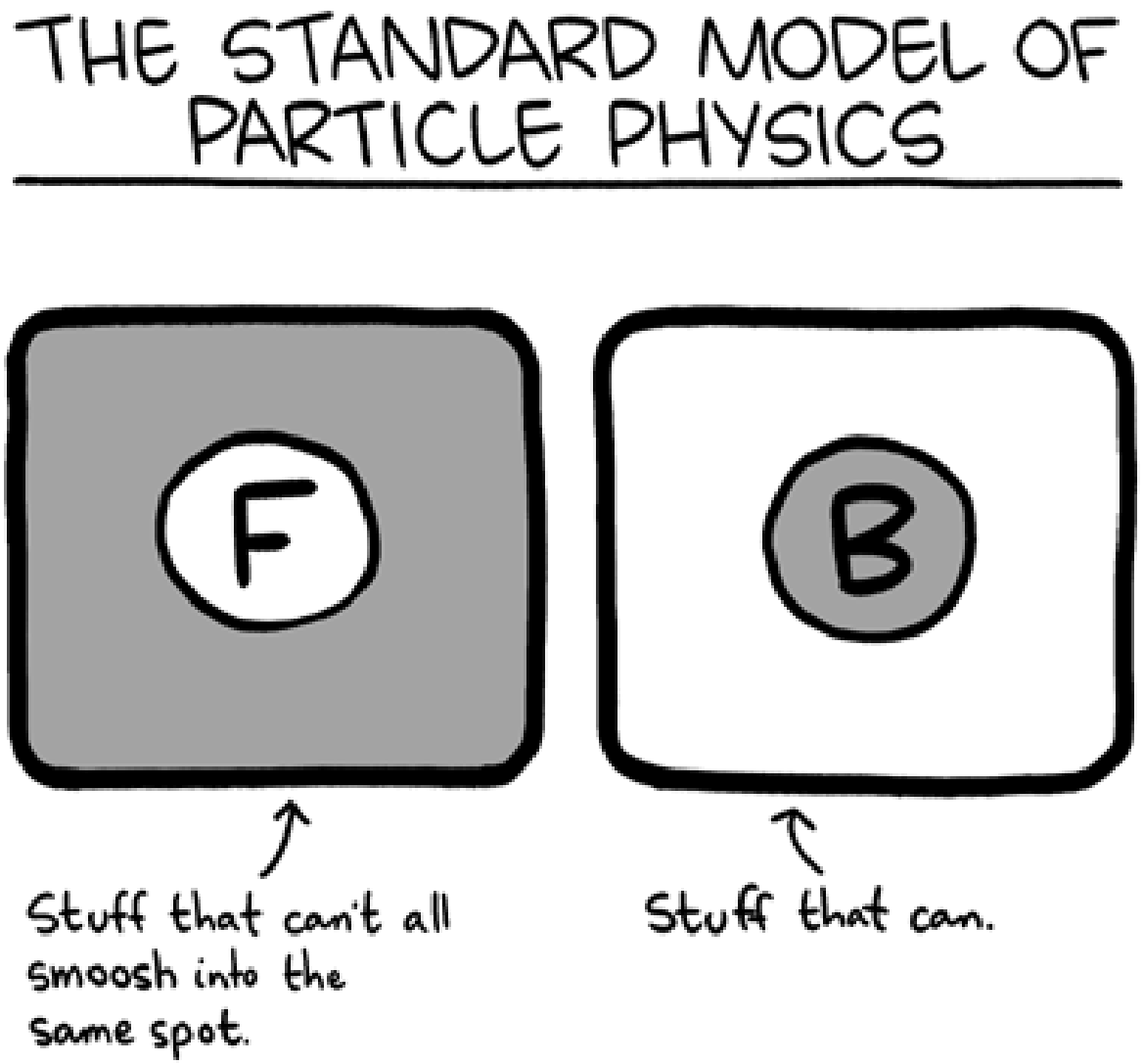
Quantum Physics: So, okay look, reality isn't packets, it's a point moving on a sphere and it's in infinite-dimensional space because...*aw man*... just forget it.

1.4 Recent Developments

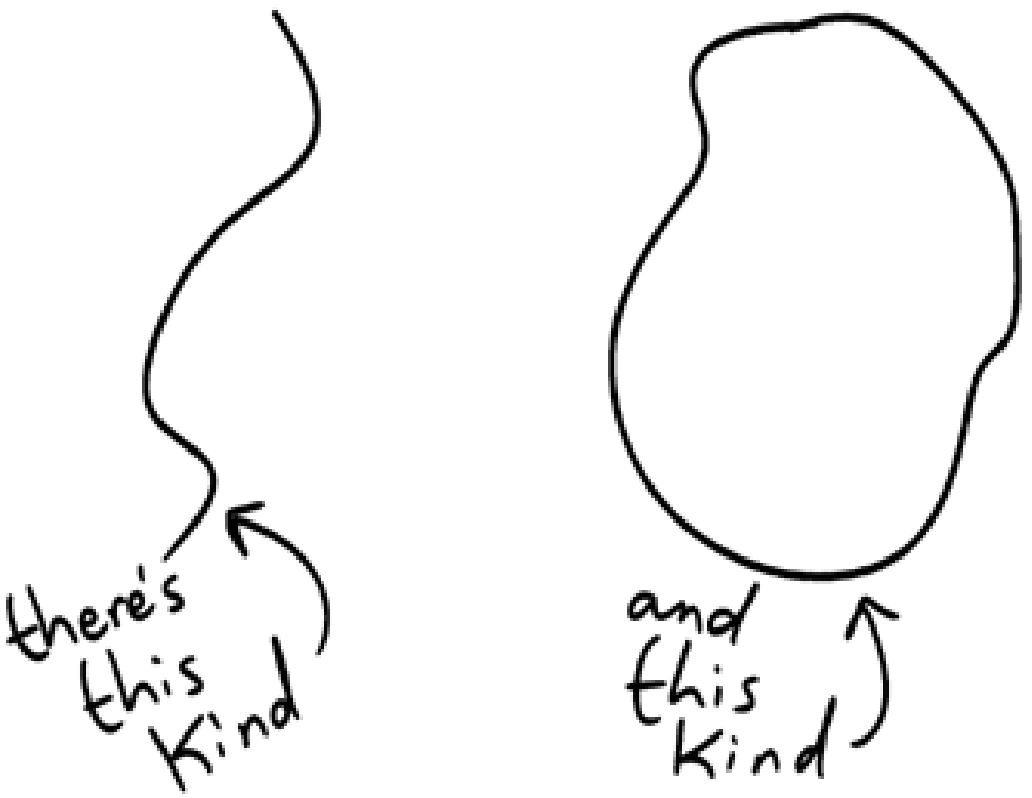
- Long-held predictions about the nature of particles and gravity have been proven startlingly correct by experiment, which sucks.
- The universe is 95% dark stuff that we don't understand. The remainder is this sticky matter that makes up things like you and smallpox.
- Gravity makes wobbles and we found the wobbles so hooray!

- Quantum mechanics and gravity still aren't on speaking terms.
- Everything in reality appears to be moving away from you as fast as it can.

1.5 Important Charts



STRING THEORY



2 CHEMISTRY

2.1 History

Ancient people figured out that you can change one thing into another thing, which helped make weapons and liquor. Subsequently, alchemists looked for gold by boiling their own pee. This sort of thing culminated in the Periodic Table of Elements.

2.2 Major Insights

- There exist fundamental elementary substances which you can split in half using spare parts from a smoke detector.
- If you go somewhere else in the universe, it's probably made of the same crap we've got here.
- If you have a fluid made of infinitely tiny particles that don't interact with each other, you can write really nice equations.

- If you want to win the Nobel Prize for Chemistry, study medicine.
- Editor’s Note: There are other interesting insights, but physics stole them during the late 18th century and won’t give them back.

2.3 Subdisciplines

Biochemistry: The study of the trillions of complex nanomachines that work together so that your body can continue to sit on the couch and digest Cheez Doodles.

Organic Chemistry: A means by which to make undergraduates cry using only carbon bonds.

Inorganic Chemistry: The thing people think you do if you say you're a chemist.

Nuclear Chemistry: The study of how you can turn a hunk of lead into gold if you're willing to spend the value of all lead and all gold.

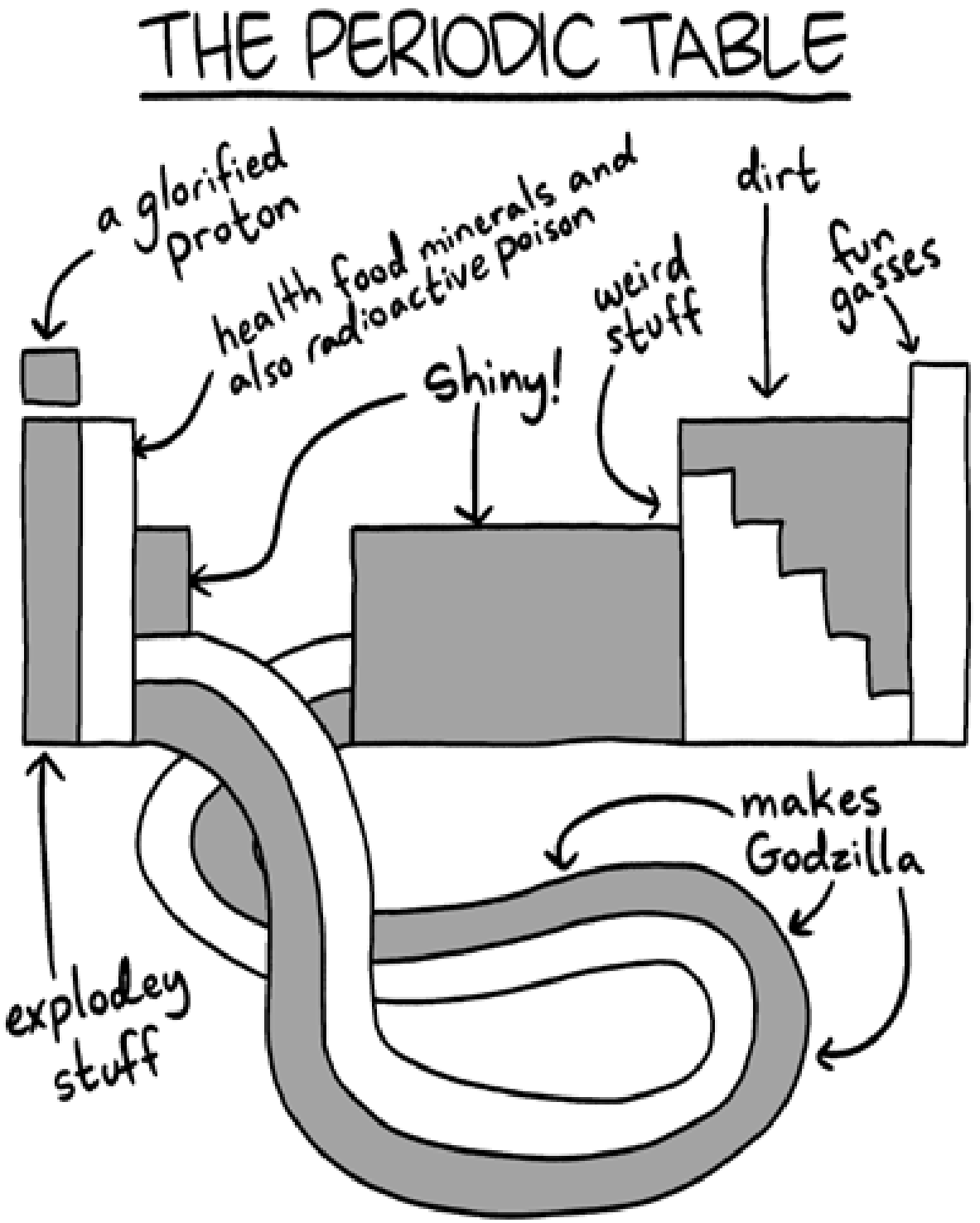
Physical Chemistry: Chemistry for cowards.

Analytical Chemistry: What you do when you have some things made of stuff and you wanna know how much stuff is in the things.

2.4 Recent Developments

None. Chemistry is “the central science,” which means if a chemist does something interesting, it will be categorized as either physics or biology.

2.5 Important Charts



3 ENGINEERING AND APPLIED SCIENCE

3.1 History

The ancient Egyptians once built a pyramid at the wrong angle, and it collapsed. The next pyramid was built at the same angle until it started to collapse, at which point they completed it by changing the plan halfway and deciding it was good enough. The general form of this procedure later led to aqueducts, steam engines, space travel, Pop Rocks, and so on.

3.2 Major Insights

- If it's broken on the outside, tape it. If it's broken on the inside, kick it.
- You can solve any big problem by creating 100 small problems.
- You can solve any 100 small problems by creating 1,000 *tiny* problems.
- If you have 1,000 tiny problems and you fix half of them, that's good enough.

- No matter how many times someone invents a flying car, people will continue complaining that there are no flying cars.
- “Done” is a null concept, which should be replaced by “works.”
- There are exactly three numbers: 0, 1, and j. The use of anything else is a form of obscurantism.

3.3 Subdisciplines

Robotics: A method for converting mechanical energy into job loss.

Medicine: The branch of applied science where the “tape it/kick it” rule is only half true.

Material Science: A field for the type of person who wants to use NASA’s statistical analyses of polyurethane viscoelasticity in order to create a slightly softer butt-cushion.

Geoengineering: The realistic assumption that it’d be easier to cast trillions of tiny mirrors into the atmosphere than to get people to stop driving SUVs.

Artificial Intelligence: The study of how to duplicate the most complex machine in Nature, then make it fix text-messaging errors.

Rocket Science: If you build a big tube and put some explodey juice in it it'll go up and you'll be in space and everyone will think you're smart hooray!

Applied Mathematics: Mathematics for traitors.

Civil Engineering: The design and creation of stuff for military engineers to blow up.

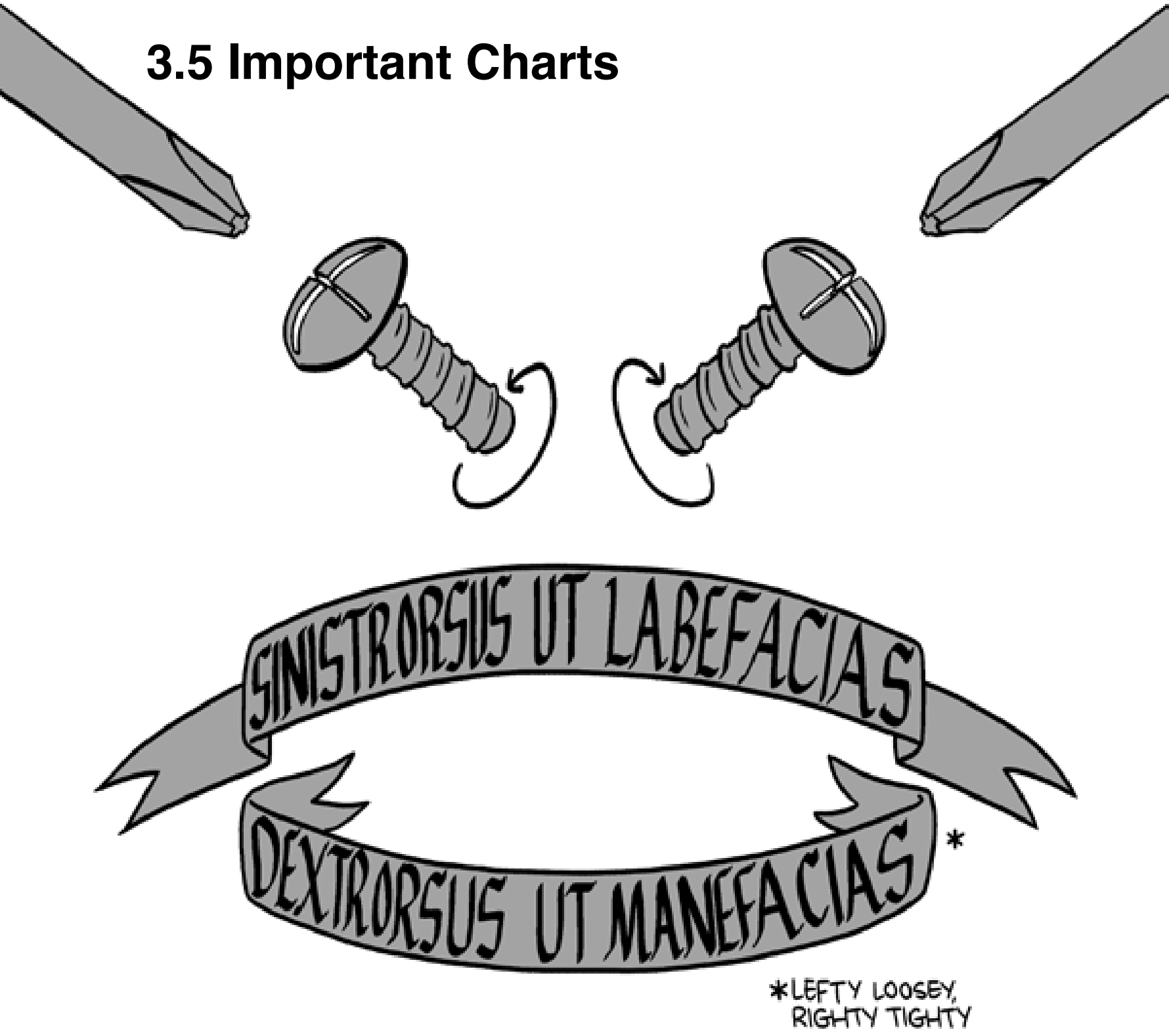
Military Engineering: A form of applied thermodynamics, focusing on rapid entropy increase for the purpose of taking somebody else's stuff.

3.4 Recent Developments

- Computers are better than us at board games, but way worse than us at slowly being rendered obsolete by their own creations.
- 3D printers can build molecules from scratch and also print kitty cat pictures made of frosting.
- All cancers can be cured as long as you are a species of the genus *Rattus*.
- Self-driving cars will soon eliminate the last thin sliver of human interaction separating you from pizza.

- The following groups can now send people to space:
  - China
  - Russia
  - The United States
  - Elon

3.5 Important Charts



4 BIOLOGY

4.1 History

Once upon a time, a self-replicating molecule appeared. It became a cell, then a clump of cells, then a squishy worm sort of thing, then a fish, then an ape, then a guy who said none of that stuff ever happened. Later, a British man worked it all out and people told him he looked like a monkey.[1]

1 It also became other stuff, but none of those other species are reading this, so it's okay for us to leave them out.

4.2 Major Insights

- All of life is made of little globs that make other little globs.
- One time a little glob captured a littler glob and made it do all the work. This sort of thing later resulted in slime mold, pukeweed, and humans.
- Your appearance and behavior are largely determined by a helical molecule that's at least 50% junk.

- It is always the case that DNA makes RNA which makes protein, except when it doesn't go like that.
- Sex probably evolved to prevent disease, which shows that Evolution has a healthy sense of irony.

4.3 Subdisciplines

Genetics: The study of specific ways you are broken at the molecular level.

Genomics: The study of all the ways you are broken at the molecular level.

Microbiology: Formerly the study of all the tiny stuff trying to kill us. Now the study of all the tiny stuff trying to kill us, plus the nice stuff you get from eating yogurt.

Creation Science: [this section intentionally left blank]

Ecology: The attempt to discover all the poorly understood species in a system, then misunderstand them at the same time.

Astrobiology: The hope that intelligent life exists somewhere in the universe.

Epidemiology: Medicine for people who like math and zombie movies.

Phylogenetics: Genealogy for people who want to trace their roots back to an abiotic chemical process.

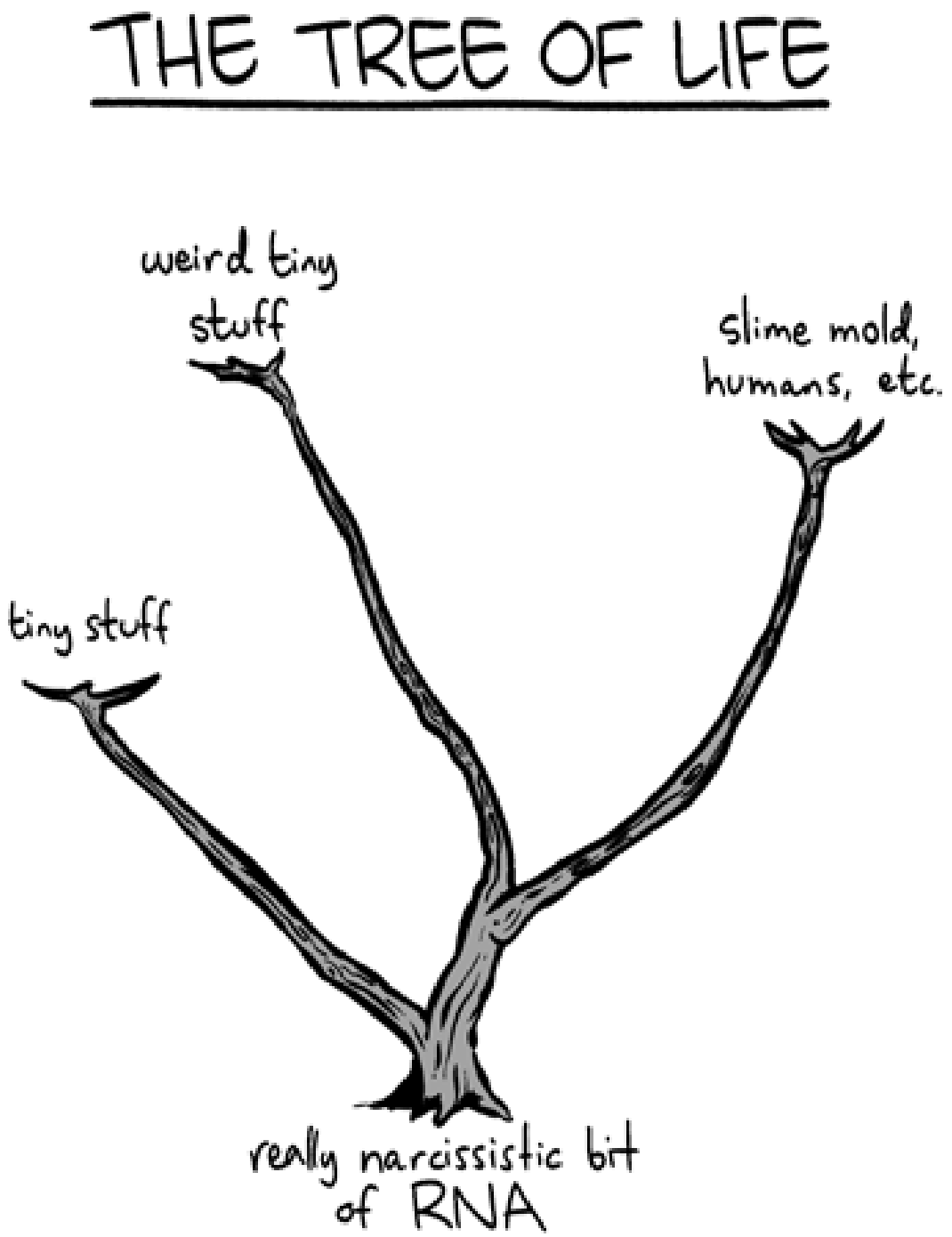
Bioinformatics: All the wonder of Nature without having to see it, smell it, hear it, taste it, touch it, or transcendentally commune with it.

4.4 Recent Developments

- We can now engineer life. It's like in *Frankenstein*, only way smaller, and we'll probably use it to make gasoline and opiates.
- T. Rex probably looked more like a giant pigeon than a giant dragon. So, maybe what killed the dinosaurs was shame.
- A gene-editing technology called CRISPR is set to fundamentally alter life on Earth as soon as its discoverers can stop fighting over who owns the rights.

- Soon, antibiotics will no longer be functional, and we will be completely exposed to bacterial infection. Or, as epidemiologists say, "we're going commando."
- We now believe humans mated with Neanderthals. We probably mated with a lot of other species, but this was the one time it produced results.
- Anything you can do, a bonobo can do while eating and having sex.
- Birds are actually *super boring* dinosaurs.
- DNA isn't 50% junk. You're 50% junk, OKAY?

4.5 Important Charts



5 EARTH SCIENCE

5.1 History

A bunch of space-junk formed into a big hot space-ball. Later it cooled down, and life formed. Then, apes evolved on its surface and tried to get it back to its earlier state.

5.2 Major Insights

- Once, a giant rock slammed into Earth, creating the apocalyptic ash-blackened hellscape that presaged the dawn of humanity.
- The Himalayas are still growing, which means that if you sit on top of Everest, you are continuously breaking mountain-climbing records.
- When Mother Earth catches a bad case of industrialization, She fights it off with a fever.
- Earth is “fine-tuned” for humans in the same sense that it was once fine-tuned for dinosaurs.

- The continents look like they fit together because land on Earth is basically a sort of broken jigsaw puzzle.
- 6,000 years is not enough time for all this crap to happen.

5.3 Subdisciplines

Meteorology: The study of “Is it gonna rain today or what?”

Climate Science: The study of “Is it gonna devastate human civilization with floods and hurricanes this century or what?”

Geology: The classification of rocks by whether they’re the crumbly kind, the shiny kind, or the kind that got smooshed.

Paleontology: The classification of rocks by whether they once had feelings.

Volcanology: Dermatology, but for planets.

Geophysics: The study of really big hunks of Earth.

Geochemistry: The study of really small hunks of Earth.

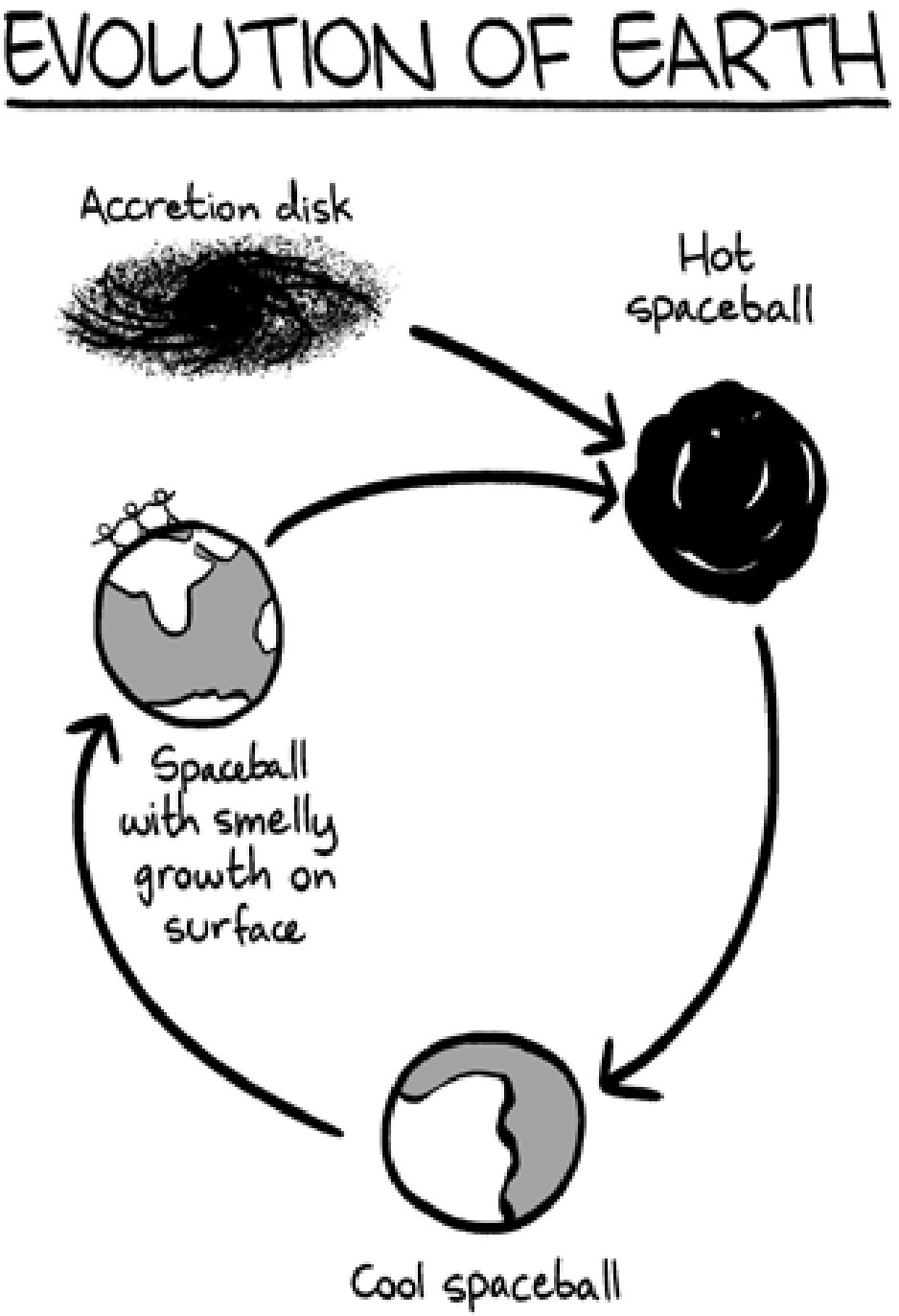
Geography: The study of various means by which to misrepresent the surface of Earth.

Oceanography: The study of what happens when you slowly carbonate an 80-quadrillion-gallon fish tank.

5.4 Recent Developments

- A vortex of plastic is forming in the middle of the Pacific. If it acquires enough old computer parts, it may become sentient and/or vengeful.
- Instead of making you go to the ocean, we can bring the ocean to your doorstep!
- The Northern Lights are probably not made of ghosts.

5.5 Important Charts



6 COGNITIVE SCIENCE

6.1 History

19th century men consulted their own thought processes and decided they were barely restrained perverts. 20th century men consulted their own thought processes and decided they were just stimulus-response machines. Later, it turned out people sometimes think about stuff, and not all of it is butts.

6.2 Major Insights

- Consciousness isn't so much the captain of the ship as a guy screaming from the mast.
- The brain is like a really powerful computer that spends most of its spare resources telling itself a story about how great it is.
- If you have an fMRI machine and enough time on your hands, you can prove pretty much anything you like.
- The Rosetta Stone of the human mind is traumatic head injuries.
- Your personality is located at the part of your brain that is most likely to get punched, which gives you a sense of how much Evolution cares about your inner self.

- Attention spans are shrinking all the time, so it's best to convey information in comically short chunks.
- If you take a few dozen students and tell them to pretend they're in a prison, you can prove that double-blind experiments are for suckers.
- If you suspect that you suck, you will probably suck. This is called the self-fulfilling prophecy. If you suspect you are great, you will probably suck. This is called the Dunning-Kruger effect. There's an obvious deduction to be made here, but you probably missed it.

6.3 Subdisciplines

Evolutionary Psychology: The notion that our brains are really well adapted for an environment we'll never encounter.

Experimental Psychology: The belief that the royal road to the psyche lies through running tests on 20 college students who are seeking course credit.

Abnormal Psychology: The study of all humans.

Neuropsychology: The understanding that sinking electrodes into your brain is easier than getting you to honestly report your own mental life.

Linguistics: The discovery that there's this thing 4-year-olds do automatically, which we barely understand.

Behavioral Economics: The attempt to make economics more rigorous by combining our bad understanding of people with our bad understanding of groups.

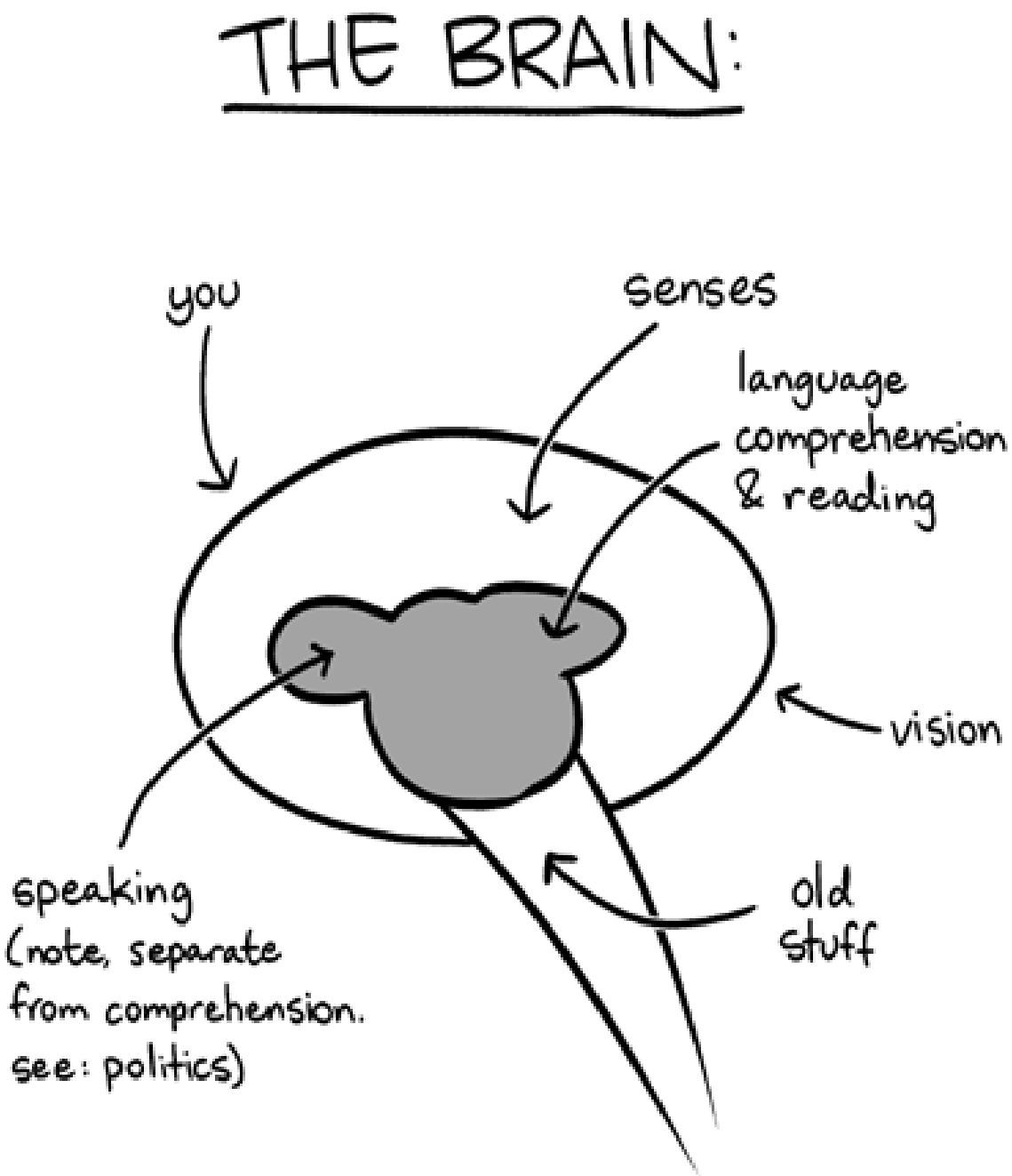
Social Psychology: The attempt to make sociology more rigorous by combining our bad understanding of groups with our bad understanding of people.

6.4 Recent Developments

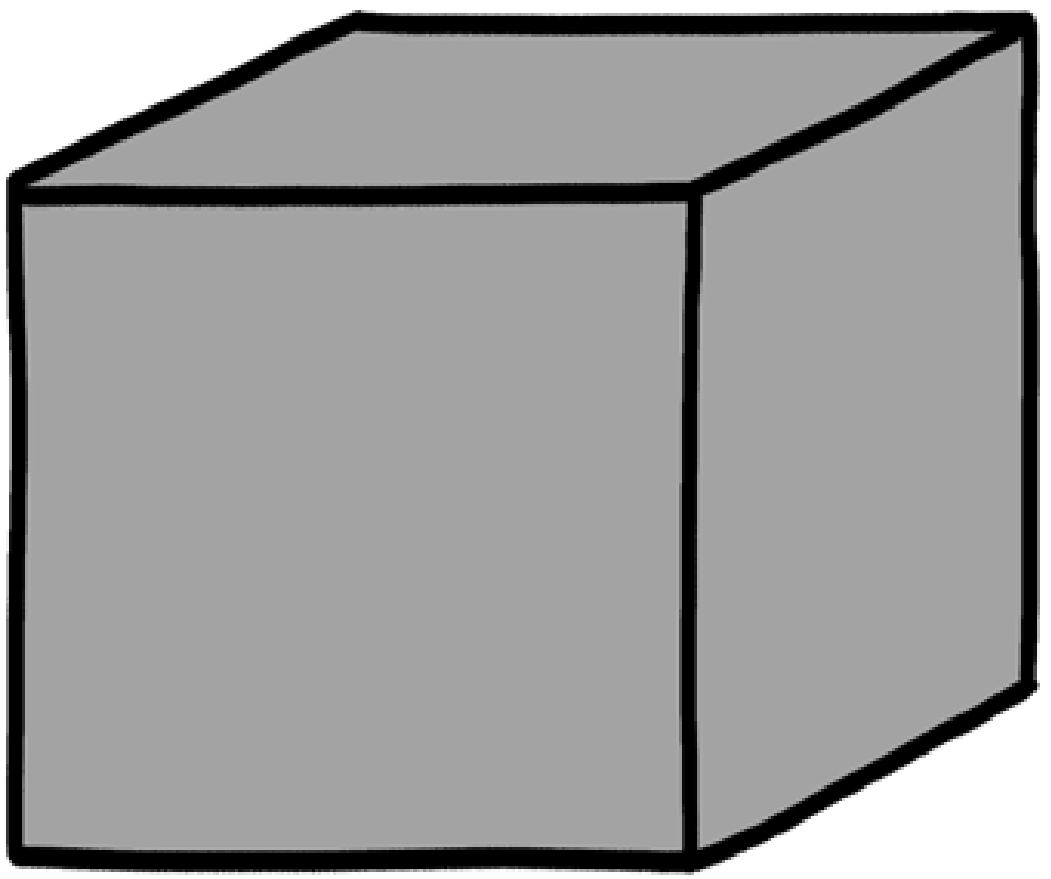
- It turns out Evolution scribbled a bunch of crap all over our blank slate.
- Intelligence probably evolved to help navigate social situations among a small group of backstabbing, self-centered primates.
- We can now connect your brain directly to a computer, so you should finally be able to play video games without having to engage your arms.

- Humans were once thought to be systematic thinkers, then thought to be stupid, then finally proven to be systemically stupid.
- Upon further consideration, it turns out that if you have a thing for your own mother, there's probably something wrong with you.

6.5 Important Charts



NECKER CUBE
(FIXED TO REMOVE AMBIGUITY)



COGNITIVE SCIENCE

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Dr. Rhett Allain
Tim Harford
Dr. Tomer Ullman
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1 For real though, if something is "wrong" to the extent the concept of wrongness is meaningful here, it is not the fault of anyone here. More often than not, I received considerate notes, found them lucid and insightful, then ignored them to make a stupid joke work.